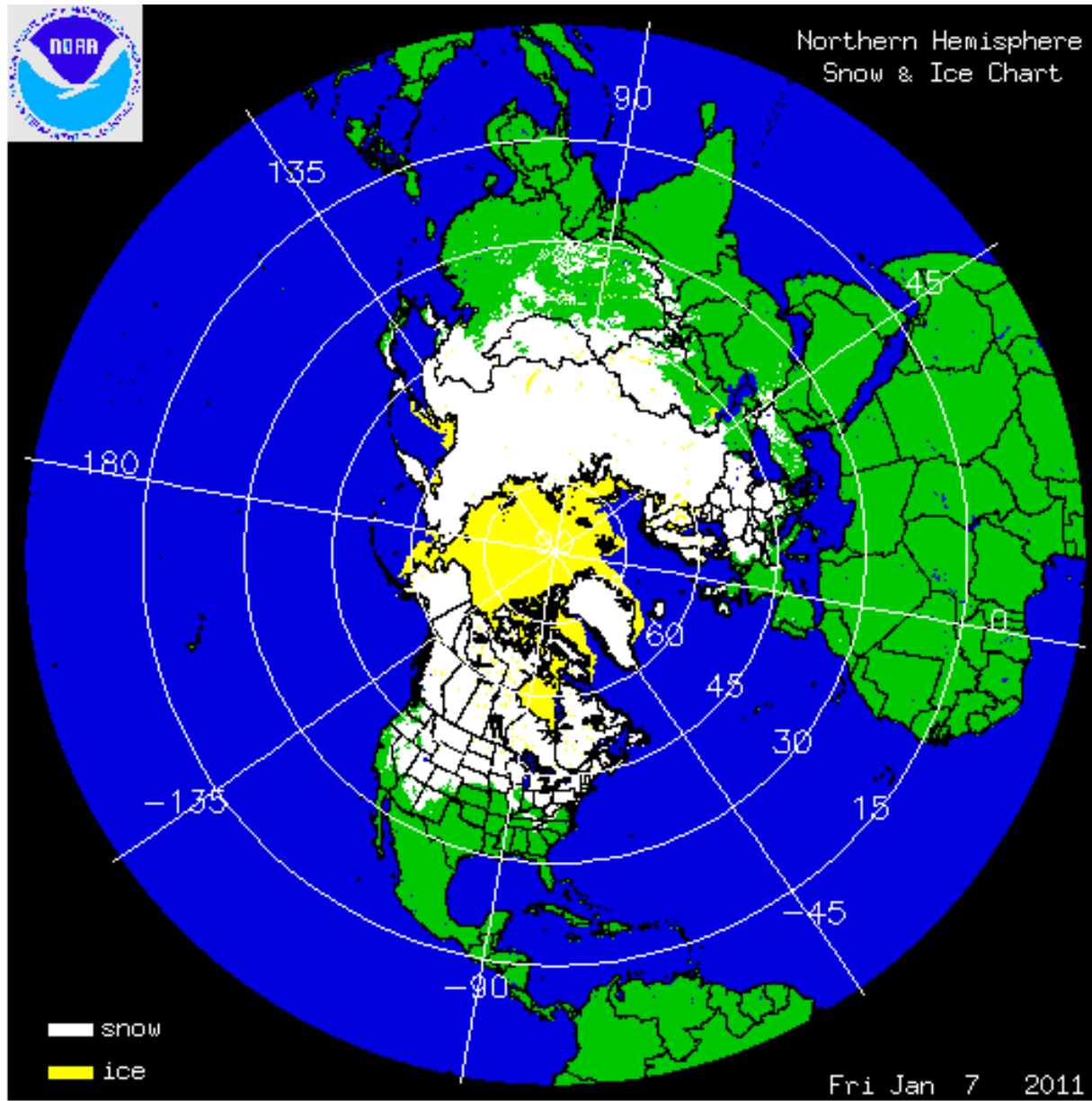


The Cryosphere



The Cryosphere

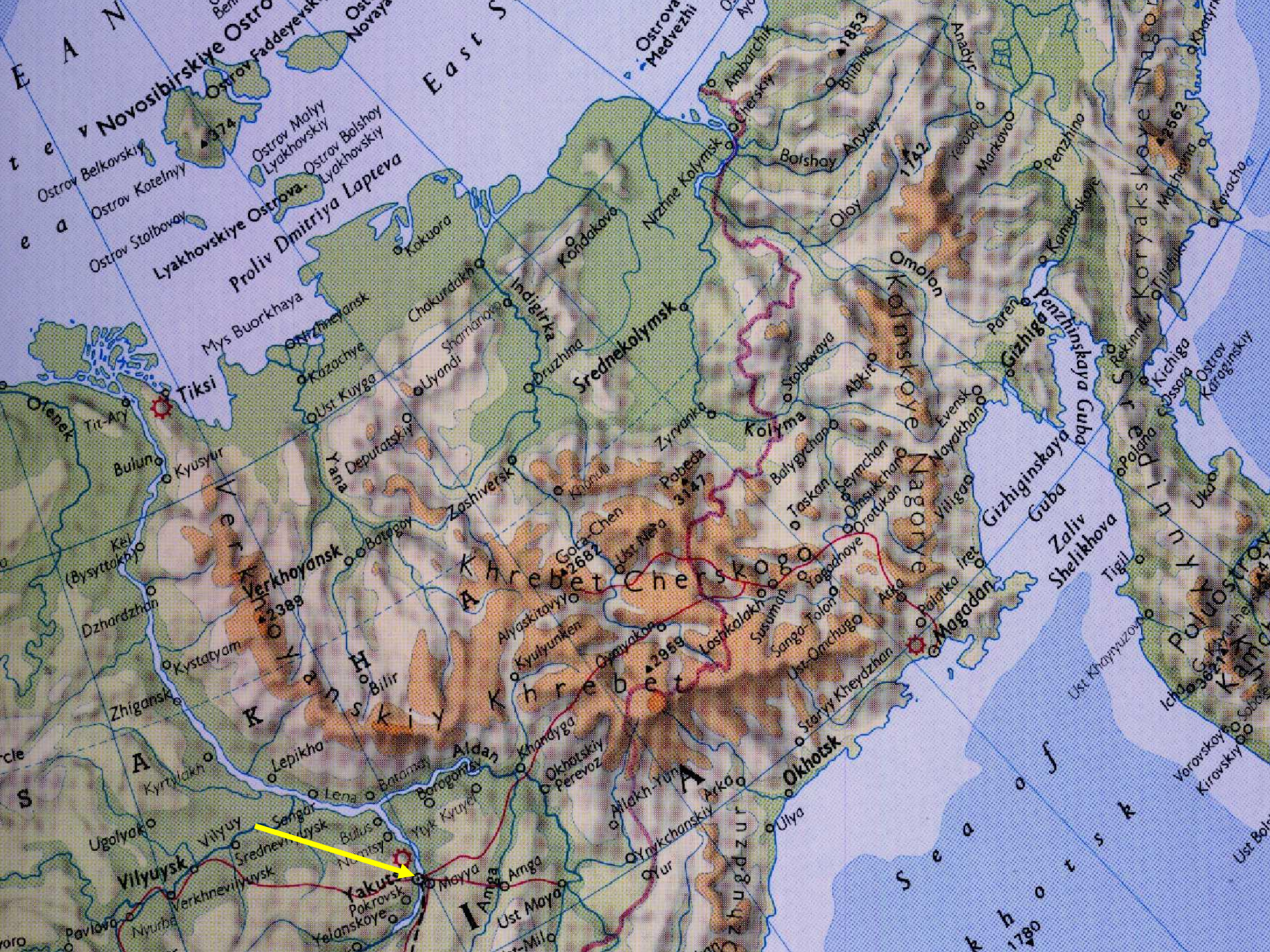
The terrestrial, non-glacial cryosphere

1: Permafrost

2: Active layer

Permafrost





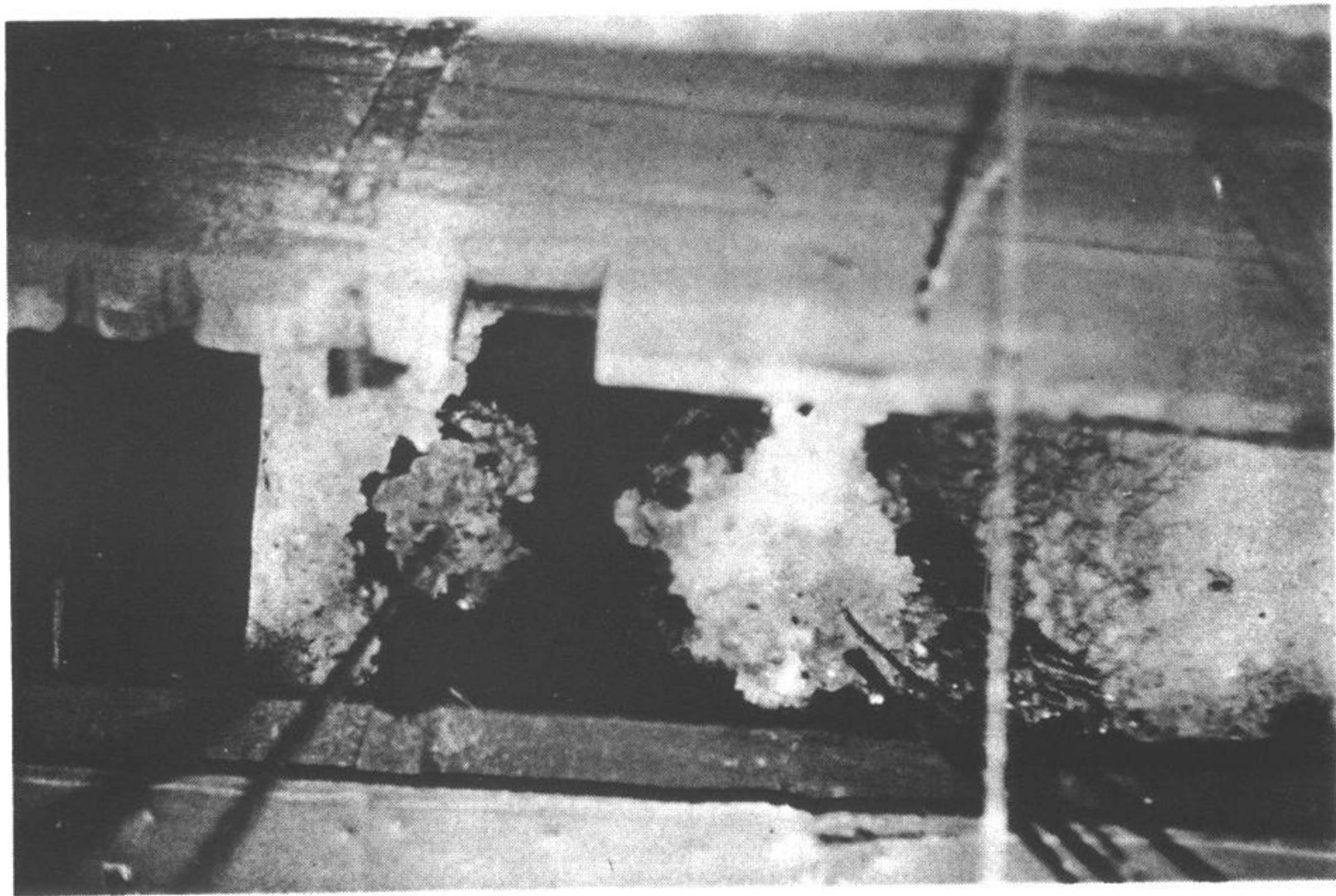


Plate I: View into the Shargin Well in Yakutsk, USSR, that was described by Academician A. F. Middendorf in 1848. The moisture condensed as ice on the walls is removed at regular intervals.



Plate II: Building Showing the Results of Thaw Settlement in Dawson City, Yukon Territory, Canada.

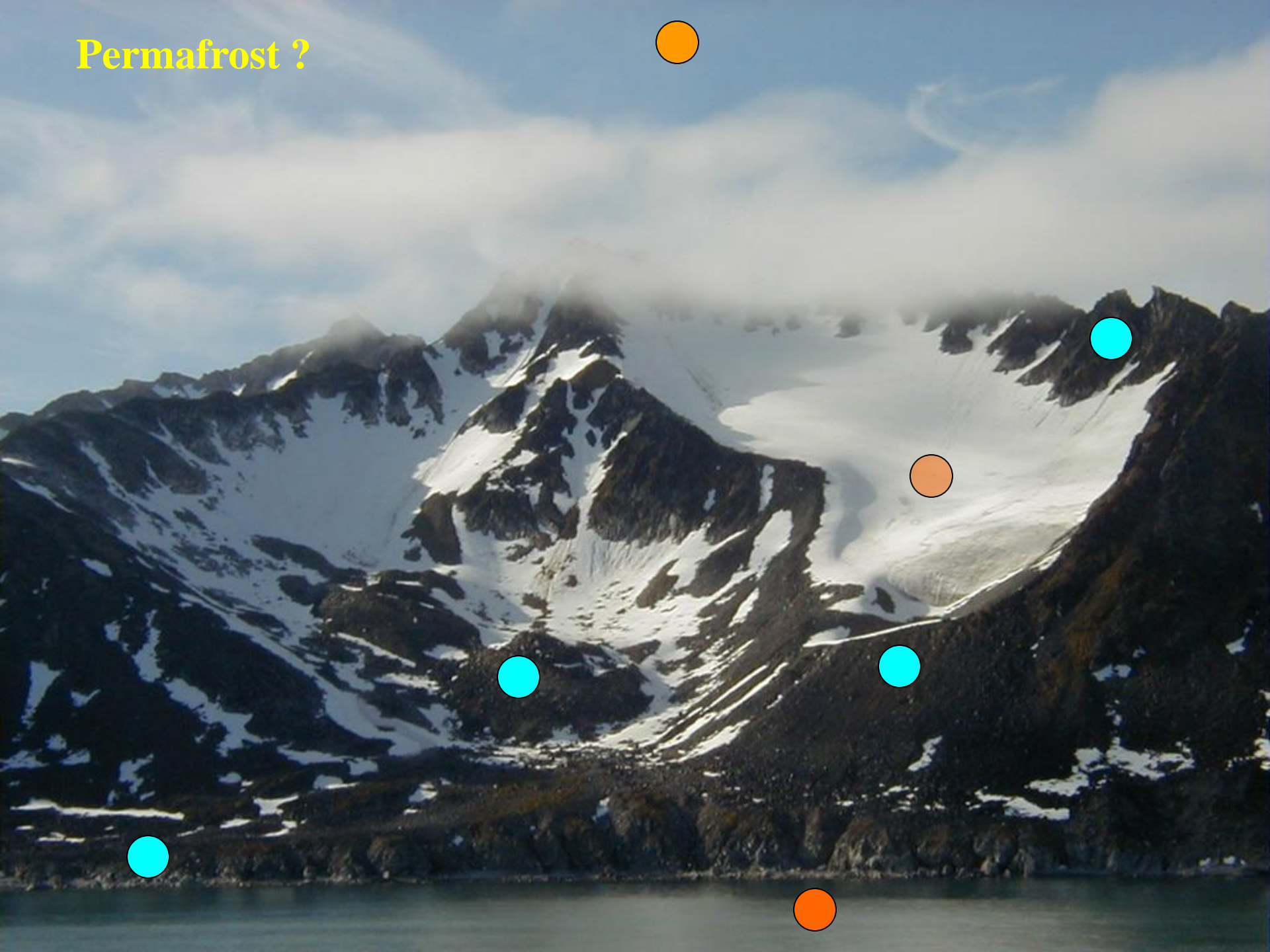
Definition of permafrost

Original permafrost definition by S.W.Muller 1945:

Permanently frozen ground or **permafrost** is defined as a thickness of soil or other superficial deposit, or even of bedrock, at a variable depth beneath the surface of the earth in which a temperature below freezing has existed continually for a long time (from two years to tens of thousands of years).

Permanently frozen ground is defined **exclusively** on the basis of temperature, irrespective of texture, degree of induration, water content, or lithologic character.

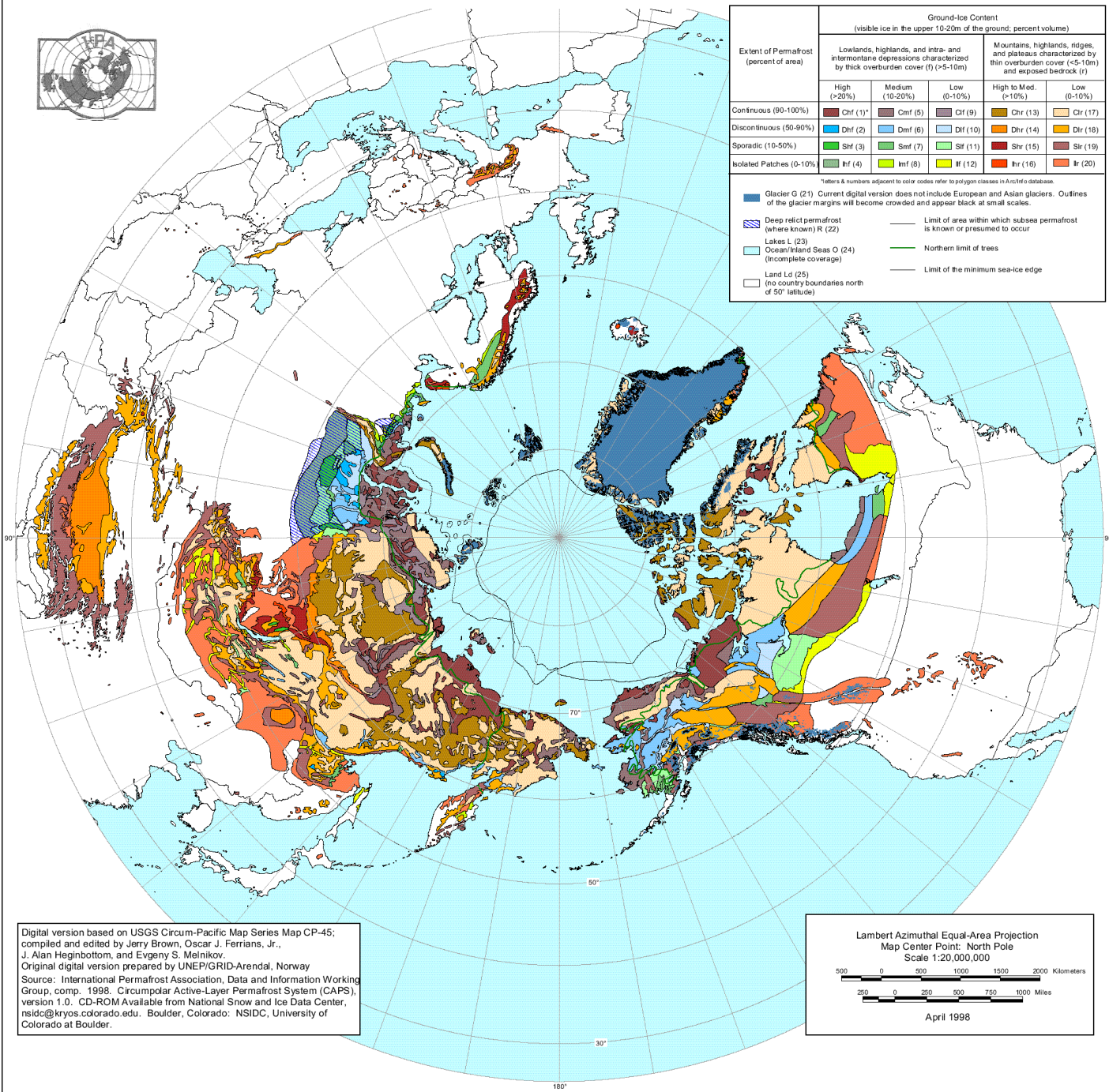
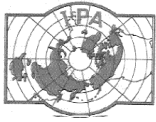
Permafrost ?



Geographical distribution of permafrost

CIRCUM-ARCTIC MAP OF PERMAFROST AND GROUND-ICE CONDITIONS

Modern permafrost distribution in the northern hemisphere



Extent of Permafrost (percent of area)	Ground-Ice Content (visible ice in the upper 10-20m of the ground; percent volume)					
	Lowlands, highlands, and intra- and intermontane depressions characterized by thick overburden cover (>5-10m)			Mountains, highlands, ridges, and plateaus characterized by thin overburden cover (<5-10m) and exposed bedrock (r)		
	High (>20%)	Medium (10-20%)	Low (0-10%)	High to Med. (>10%)	Low (0-10%)	
Continuous (90-100%)	CHf (1)*	Cmf (5)	Clf (9)	Chr (13)	Clr (17)	
Discontinuous (50-90%)	DHf (2)	Dmf (6)	Dlf (10)	Dhr (14)	Dlr (18)	
Sporadic (10-50%)	SHf (3)	Smf (7)	Slf (11)	Shr (15)	Slr (19)	
Isolated Patches (0-10%)	IHf (4)	Imf (8)	Ilf (12)	Ihr (16)	Ilr (20)	

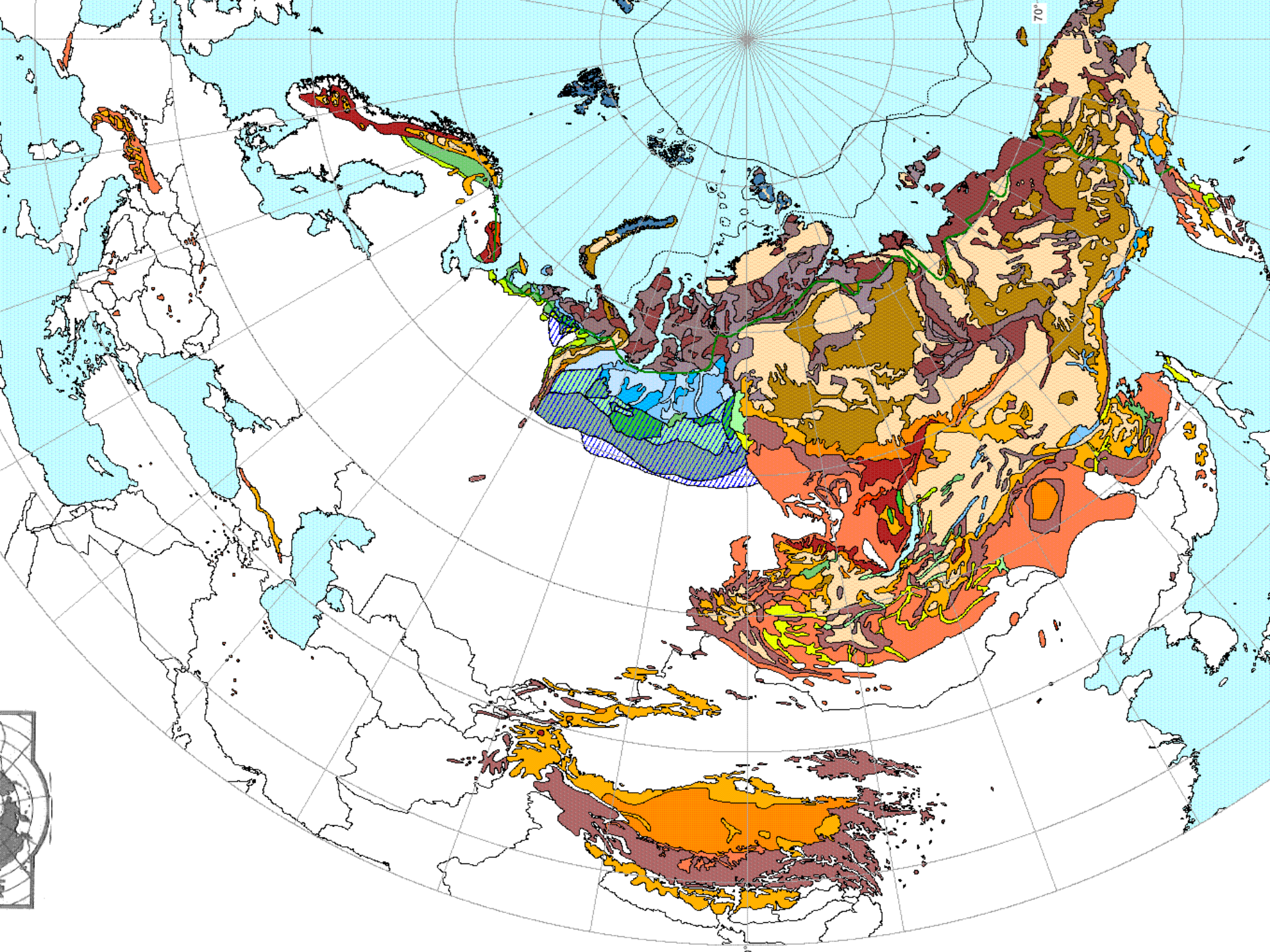
*Letters & numbers adjacent to color codes refer to polygon classes in ArcInfo database.

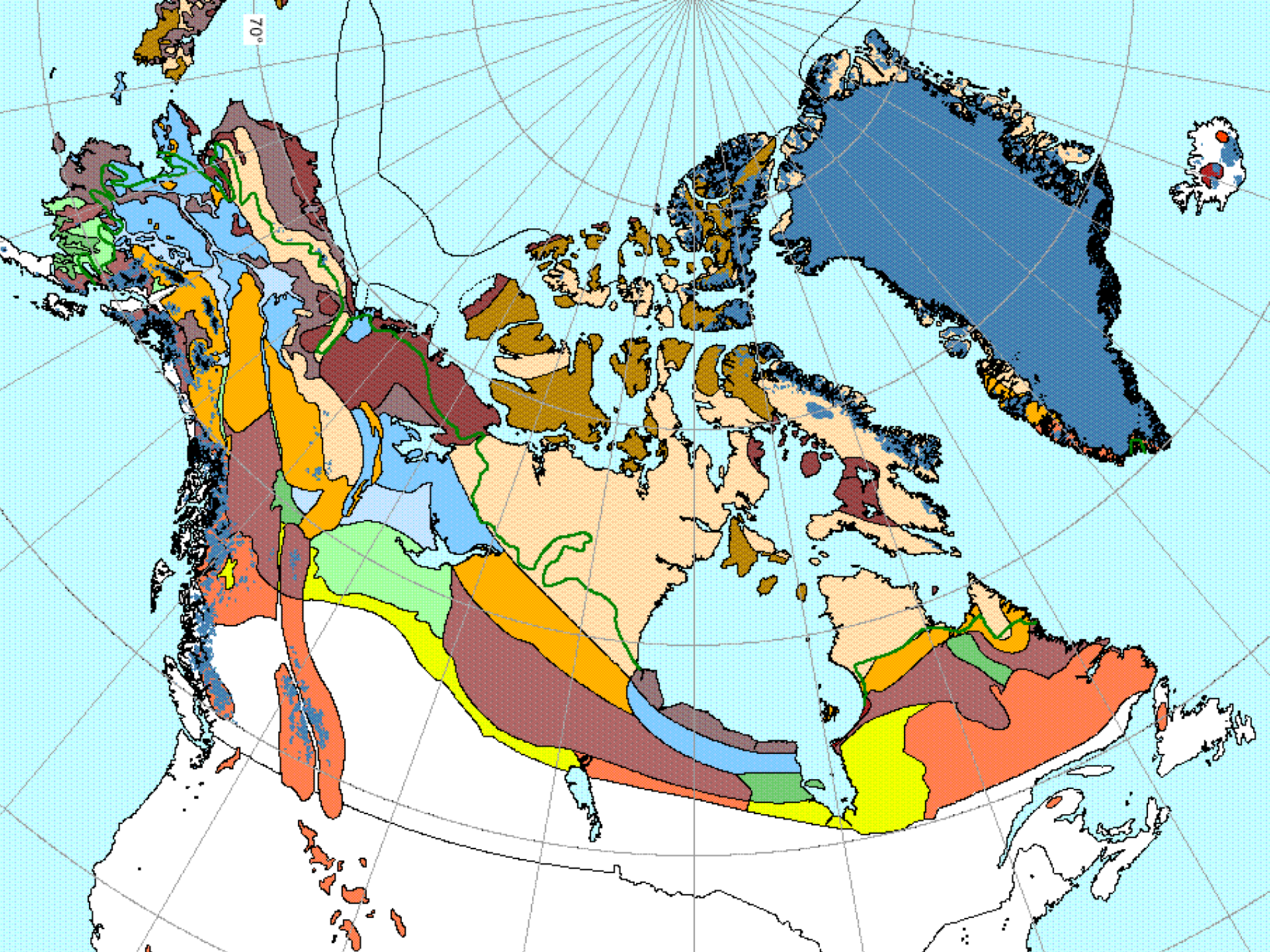
- Glacier G (21) Current digital version does not include European and Asian glaciers. Outlines of the glacier margins will become crowded and appear black at small scales.
- Deep relict permafrost (where known) R (22)
- Lakes L (23)
- Ocean/Inland Seas O (24) (Incomplete coverage)
- Land Ld (25) (no country boundaries north of 50° latitude)
- Limit of area within which subsea permafrost is known or presumed to occur
- Northern limit of trees
- Limit of the minimum sea-ice edge

Digital version based on USGS Circum-Pacific Map Series Map CP-45; compiled and edited by Jerry Brown, Oscar J. Ferrians, Jr., J. Alan Heginbottom, and Evgeny S. Melnikov. Original digital version prepared by UNEP/GRID-Arendal, Norway. Source: International Permafrost Association, Data and Information Working Group, comp. 1998. Circumpolar Active-Layer Permafrost System (CAPS), version 1.0. CD-ROM Available from National Snow and Ice Data Center, nsidc@kryos.colorado.edu. Boulder, Colorado: NSIDC, University of Colorado at Boulder.

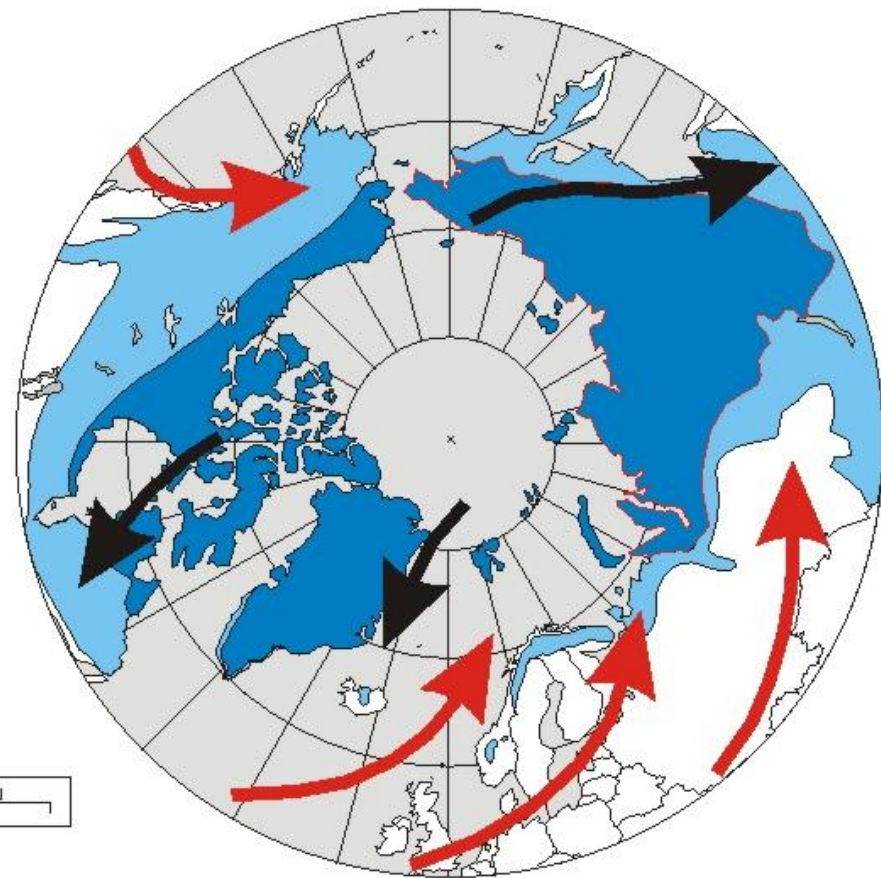
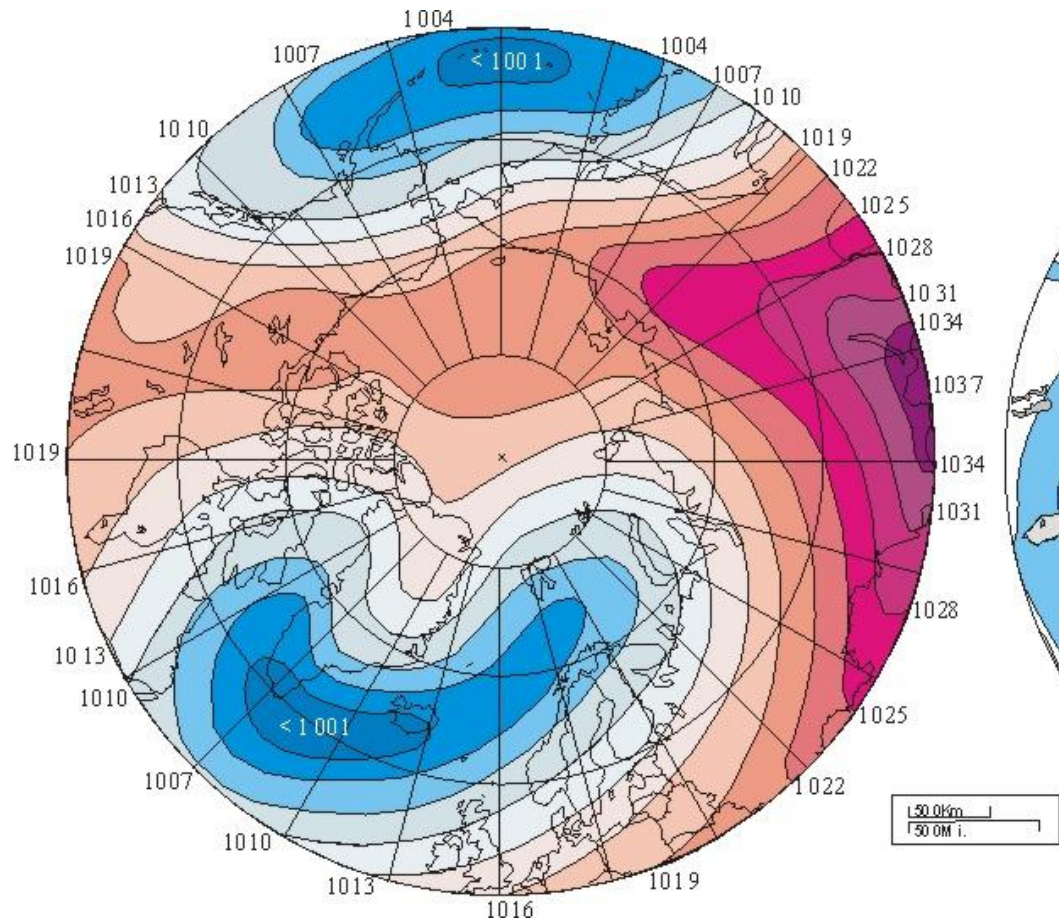
Lambert Azimuthal Equal-Area Projection
 Map Center Point: North Pole
 Scale 1:20,000,000

April 1998



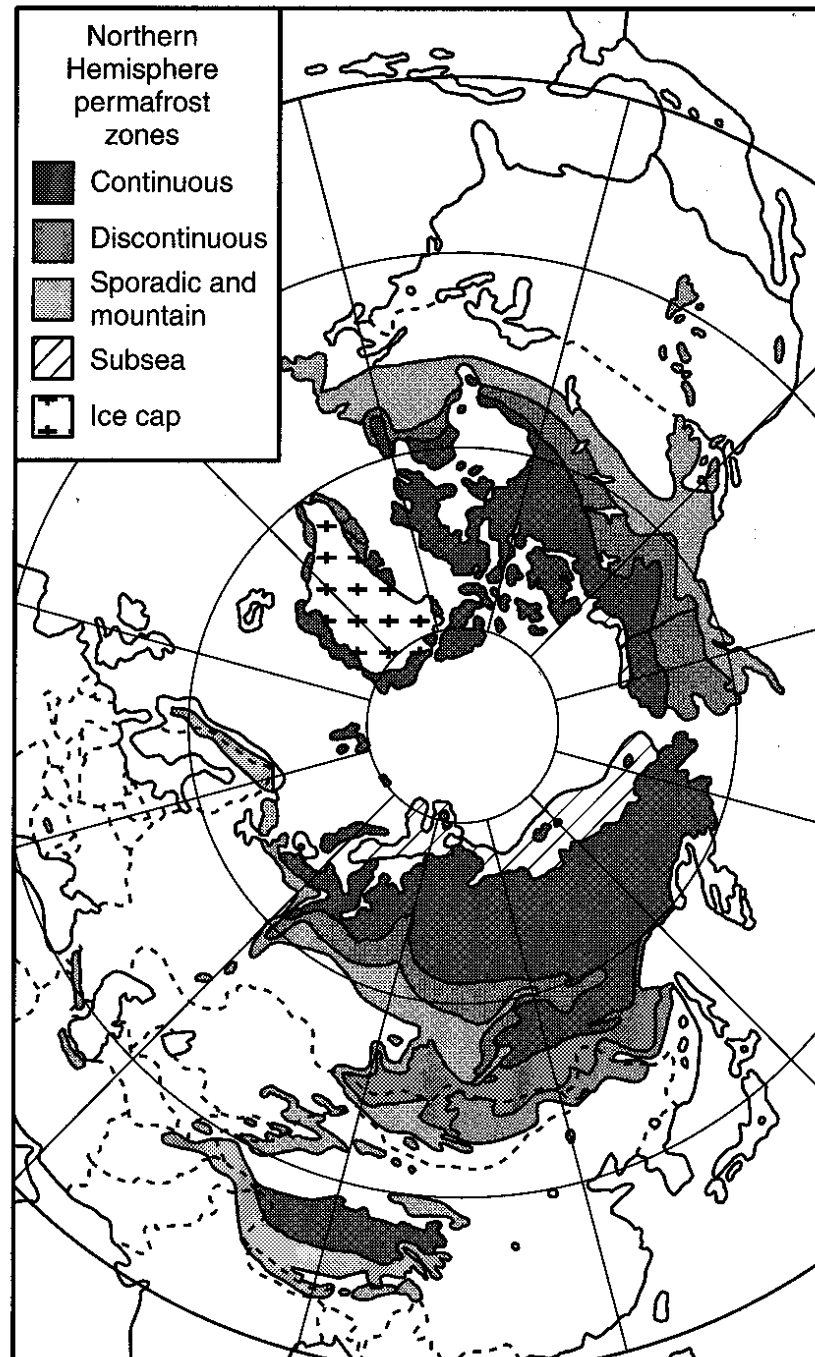


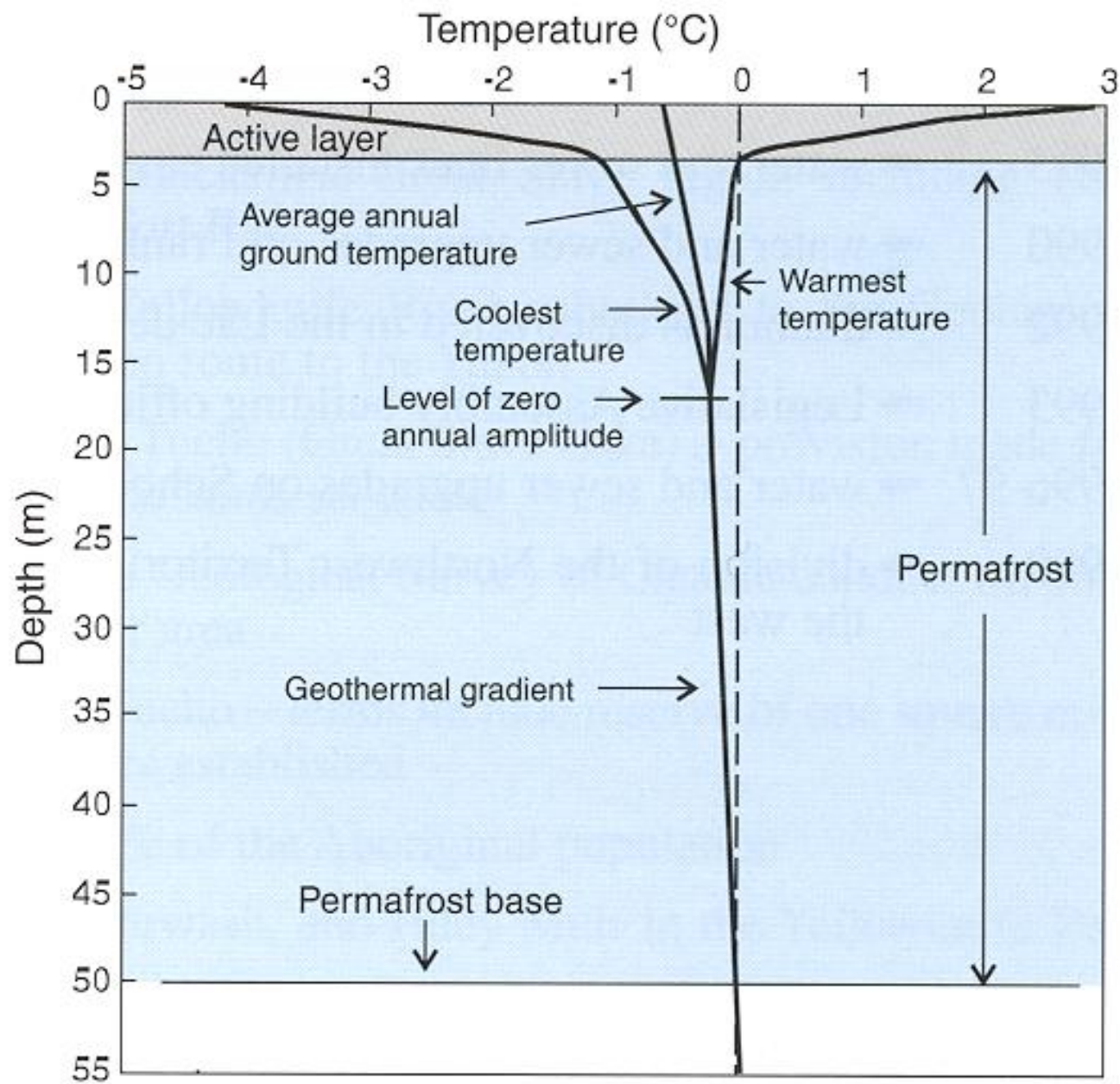
Climatic control on permafrost

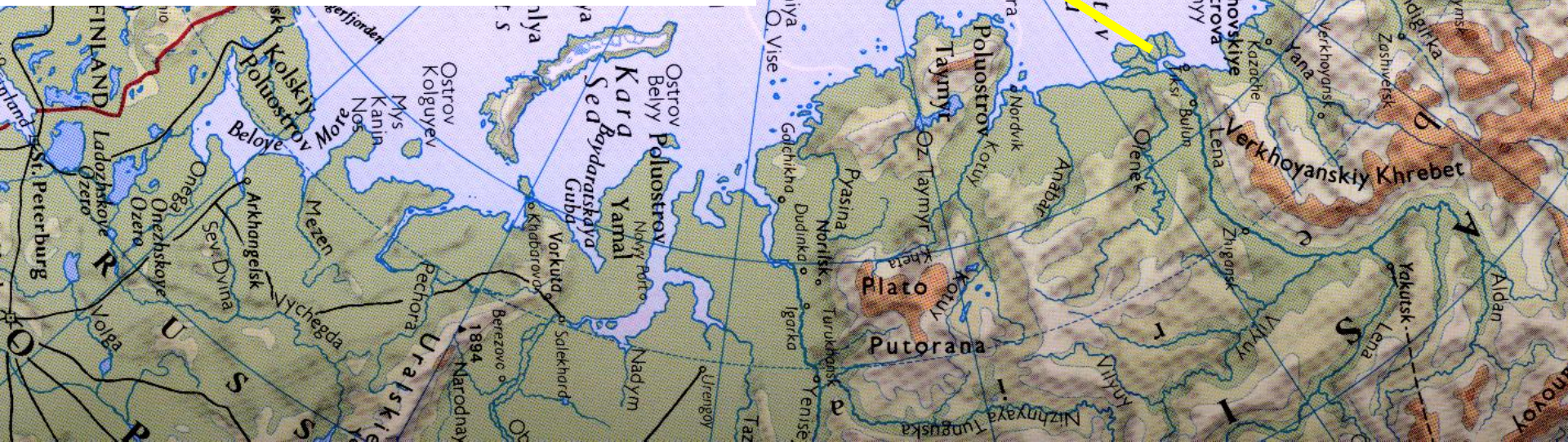
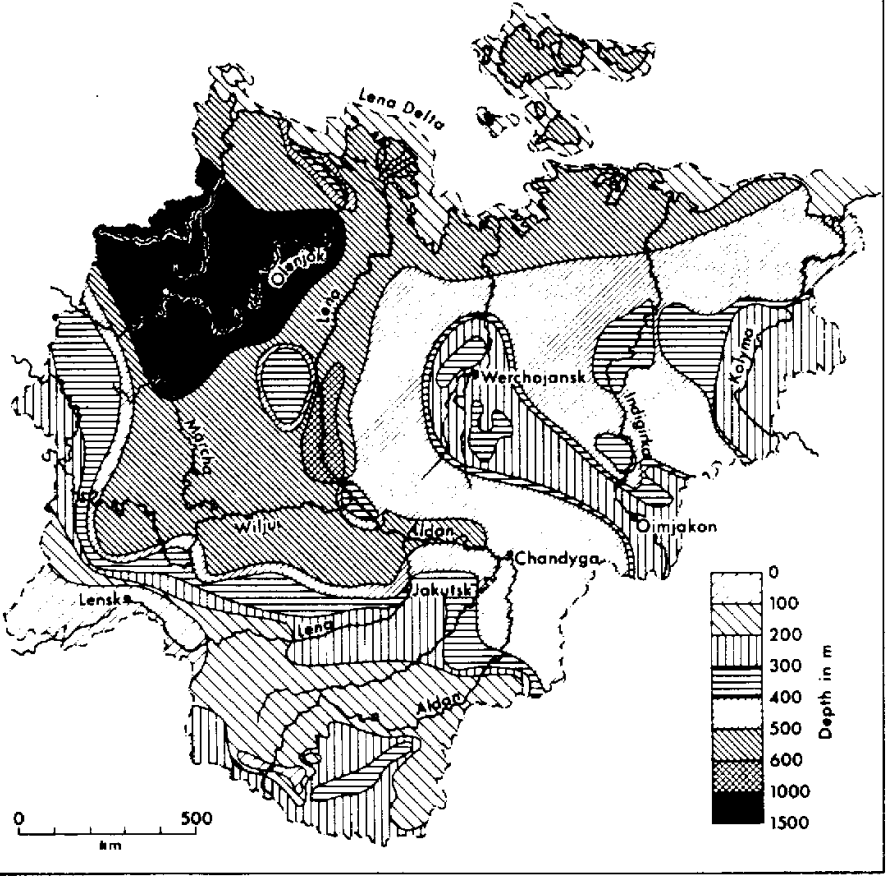


Thickness of permafrost

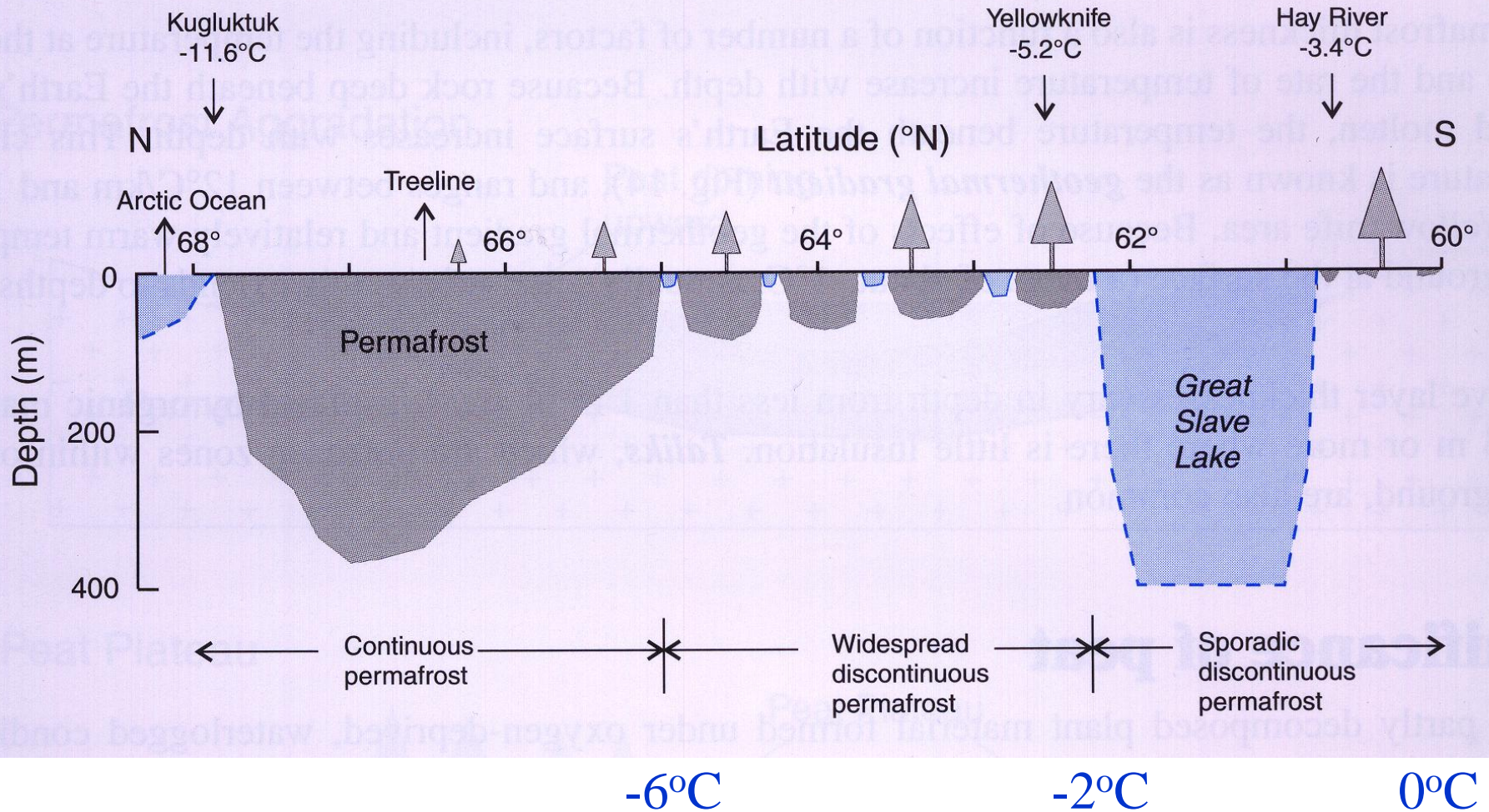
Thickness of permafrost ?



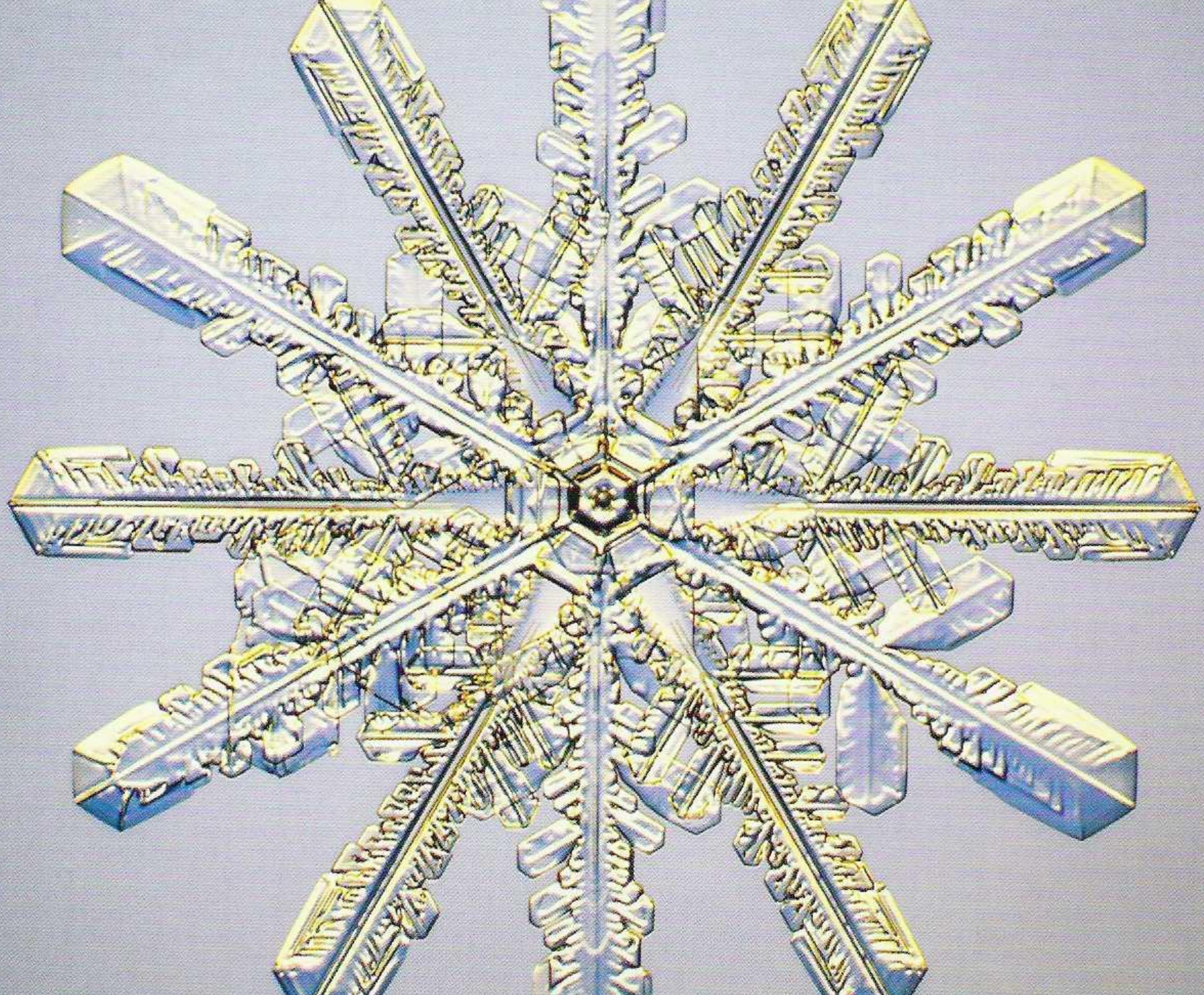




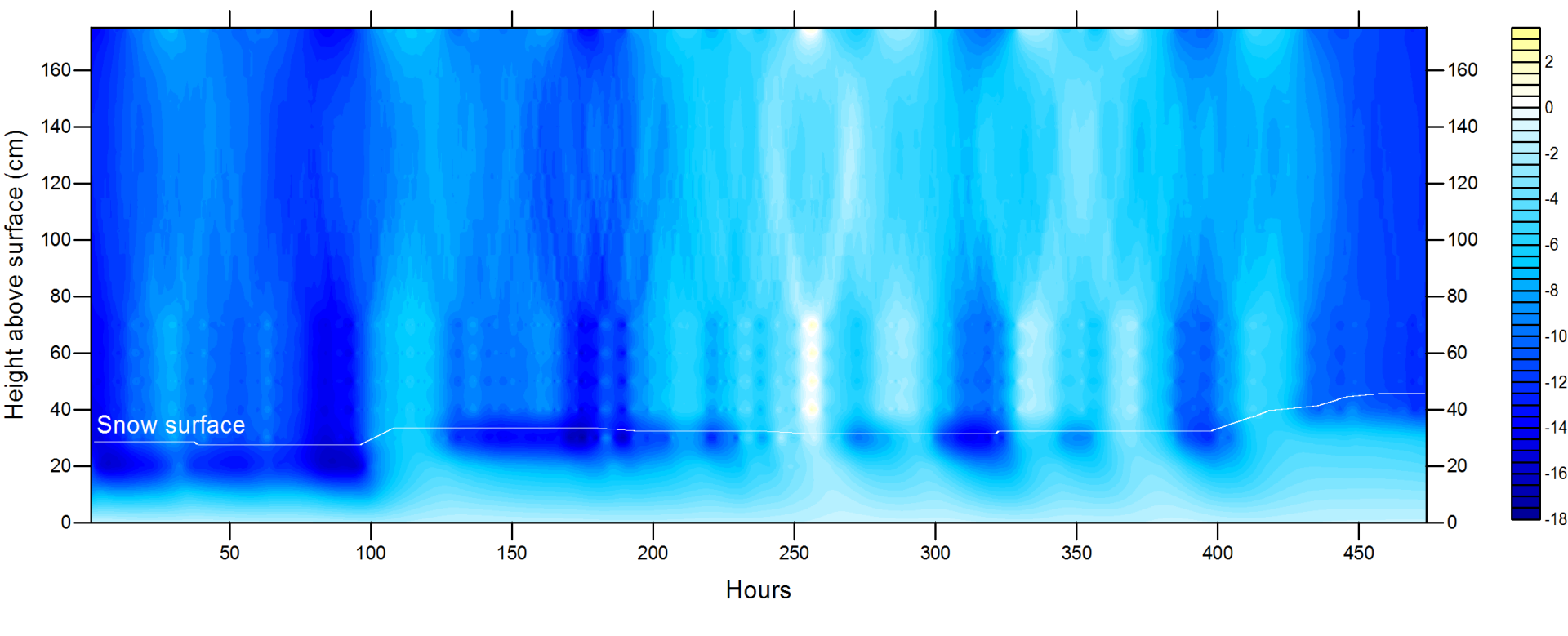
Permafrost transect north-south in Canada



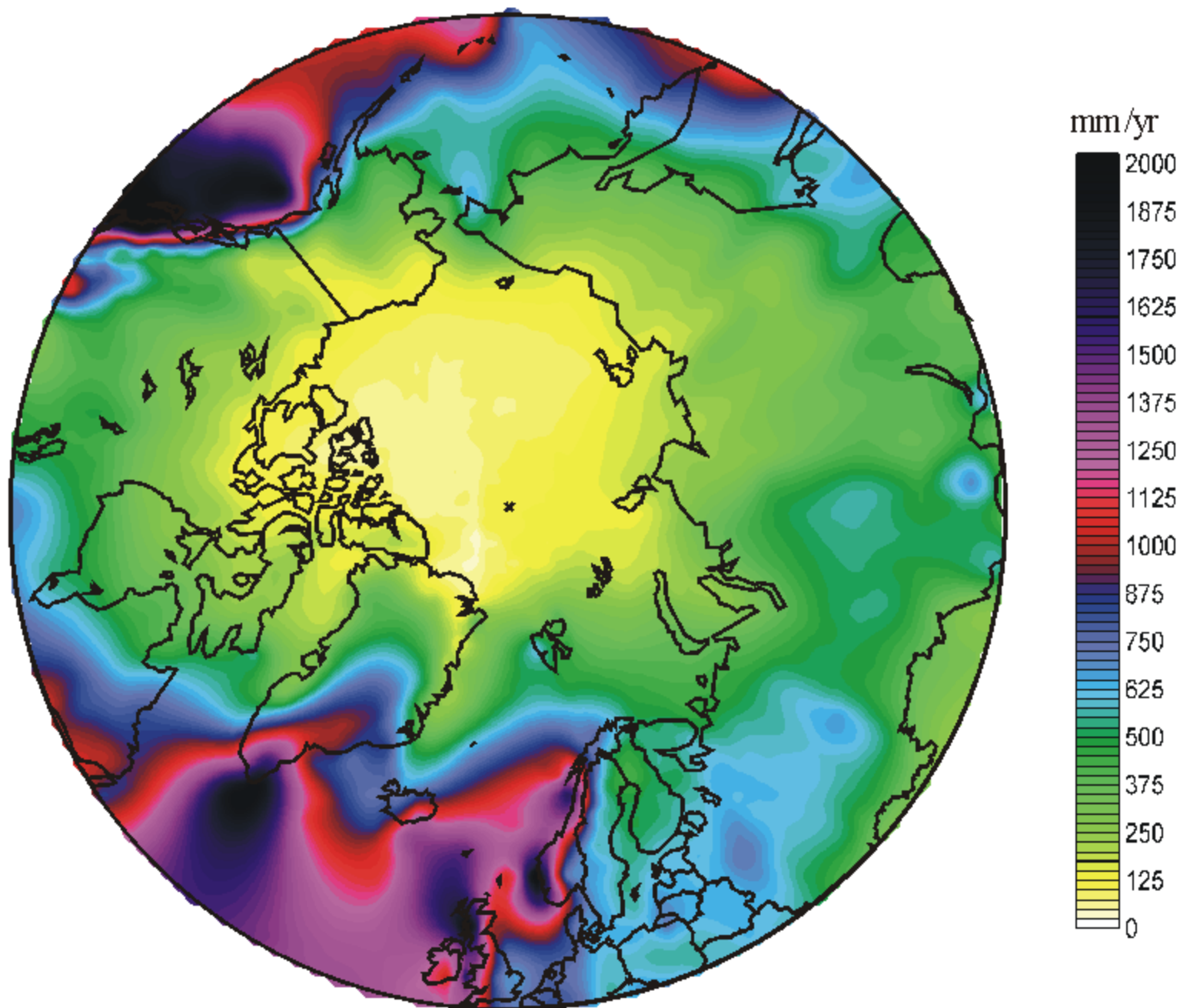
Influenze of snow cover



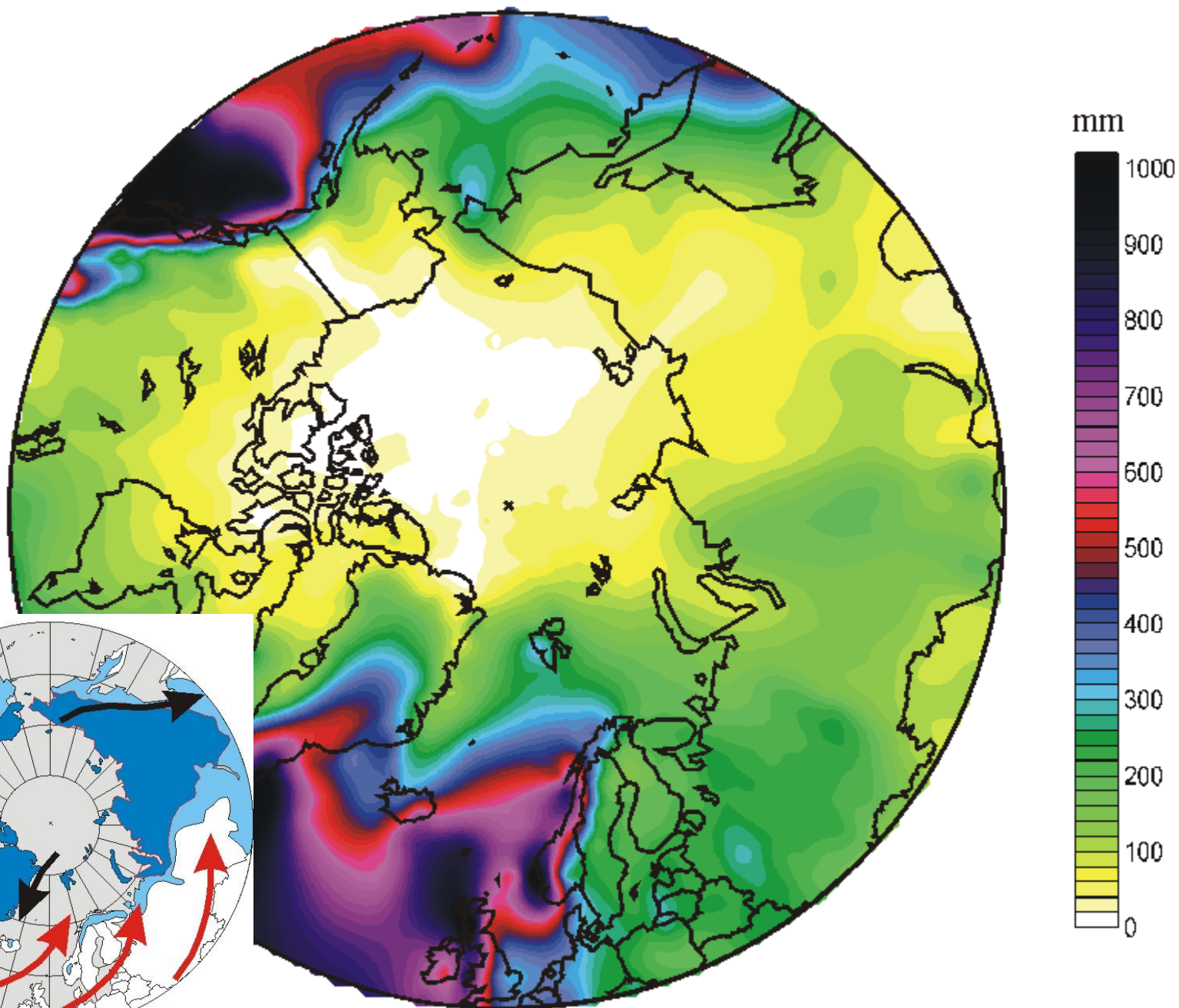


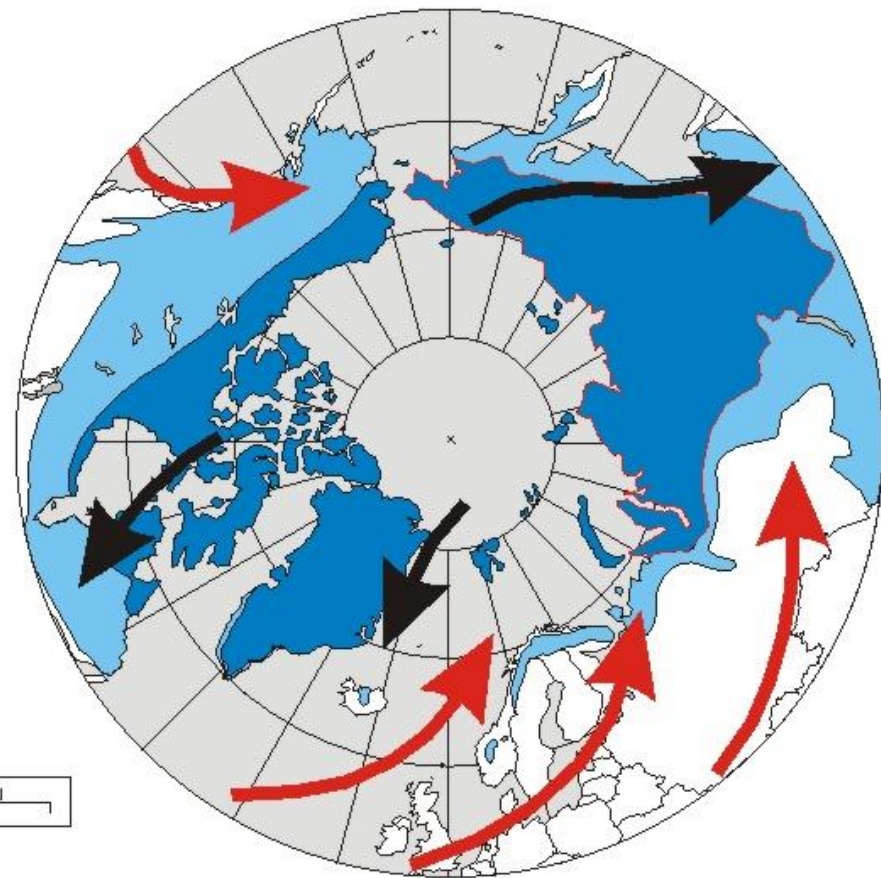
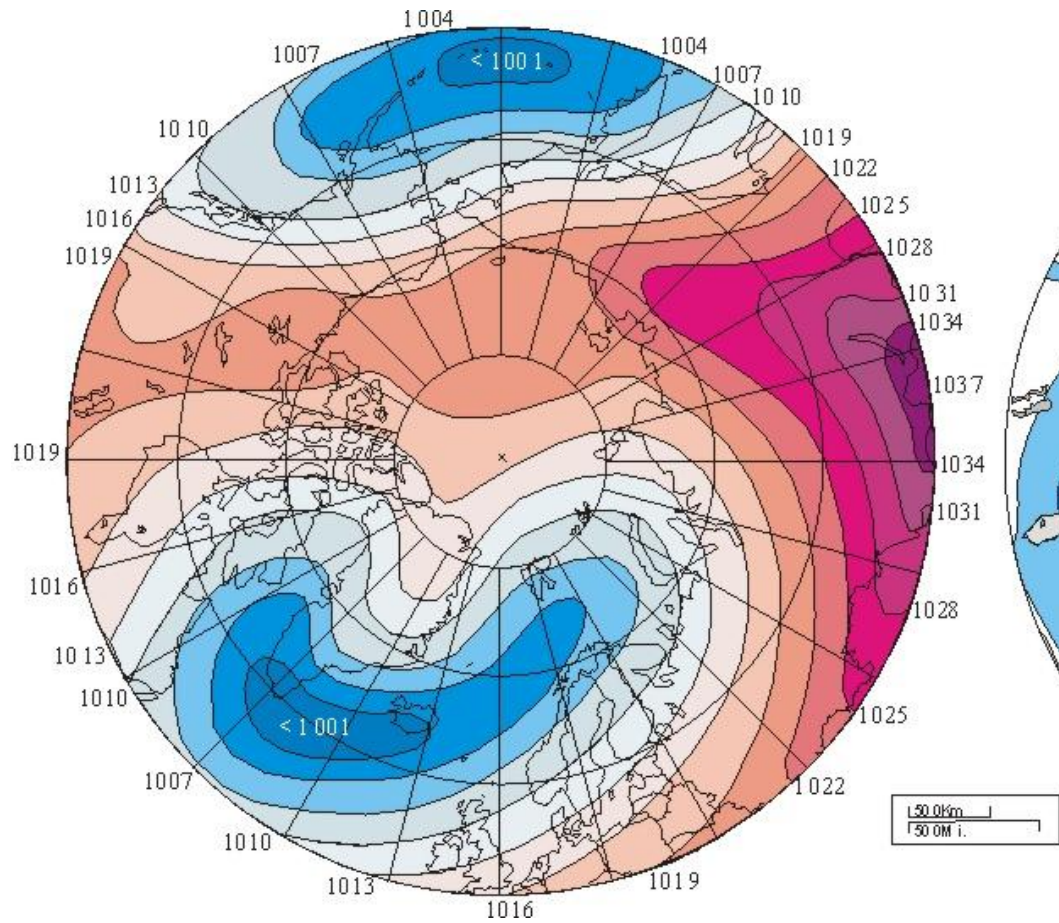


Precipitation annual average 1901-2000 (mm)



Precipitation cold season 11-04 average 1901-2000 (mm)





Water: Liquid and solid

Water is a peculiar material !



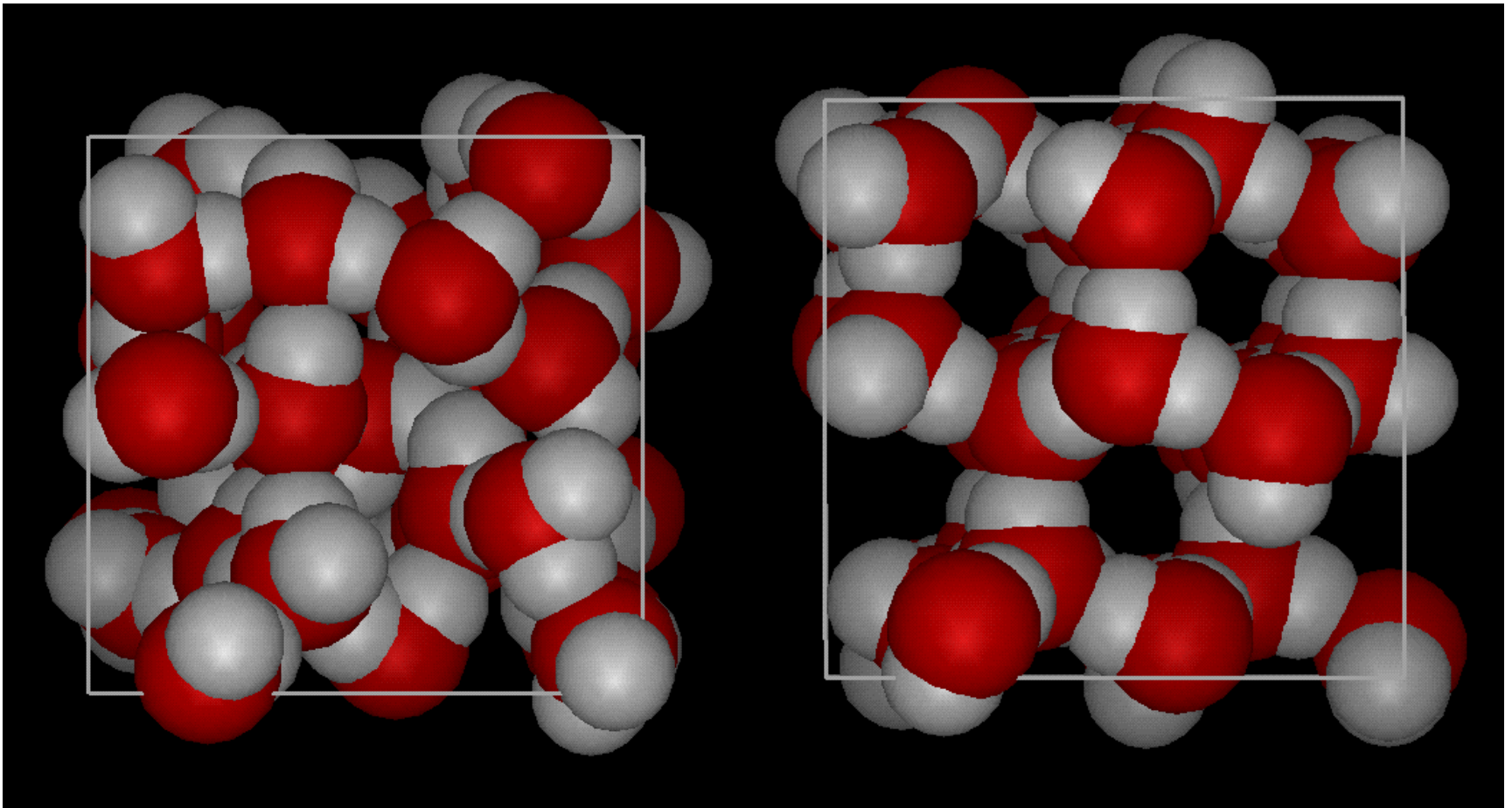
Water (H₂O) is the most abundant compound on Earth's surface, covering about 70% of the planet's surface. In nature it exists in liquid, solid, and gaseous states.

At room temperature, it is a nearly colorless with a hint of blue, tasteless, and odorless liquid. Many substances dissolve in water and it is commonly referred to as the universal solvent. Because of this, water in nature and in use is rarely pure and some of its properties may vary slightly from those of the pure substance.

Water is the only common substance found naturally in all three common states of matter and it is essential for life on Earth. Water usually makes up 55% to 78% of the human body.

Liquid water

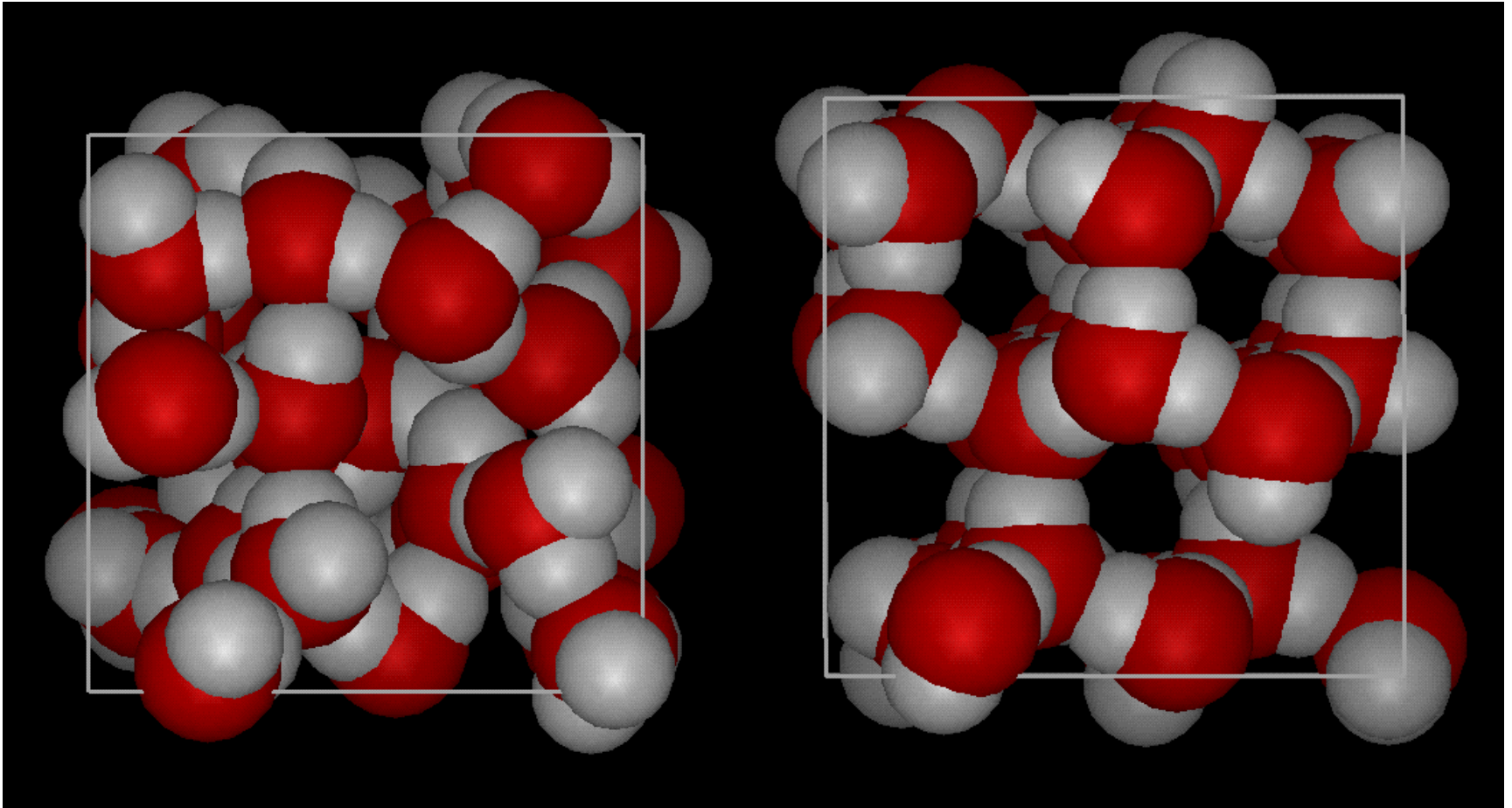
Ice



The **lattice structure of ice** makes ice less dense than water. Therefore ice floats in water, which is extremely peculiar because virtually every other substance gets more dense (about 10%) when it changes from the liquid to the solid state, so the solidifying portion sinks to the bottom.

Liquid water

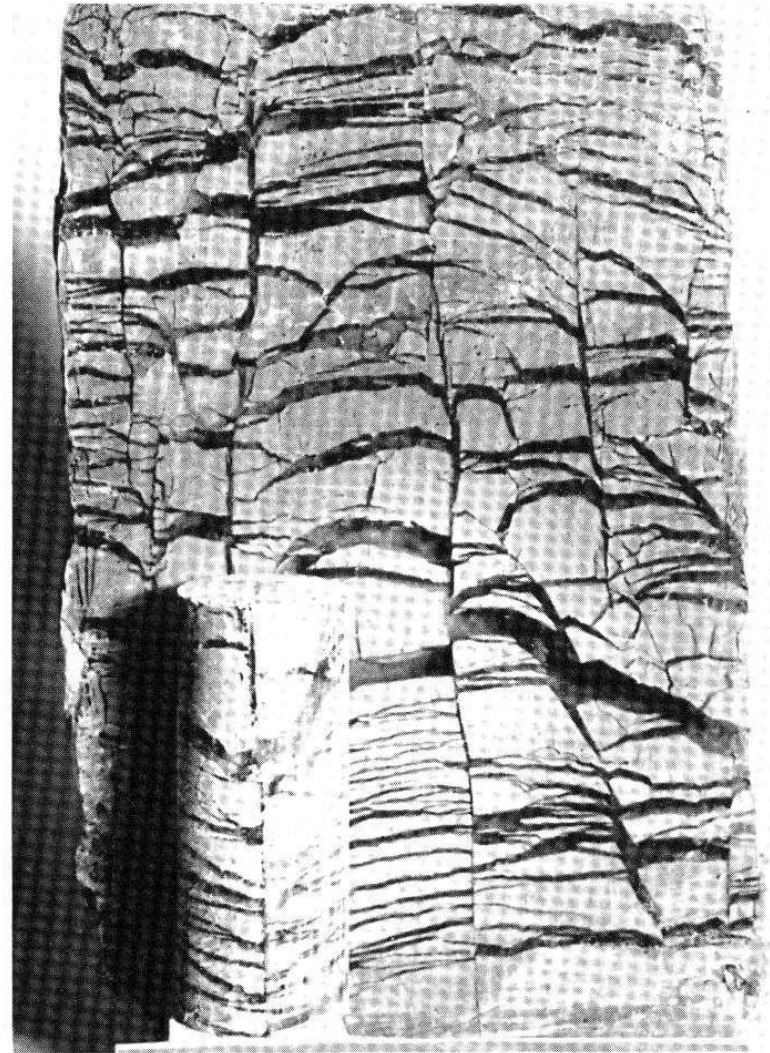
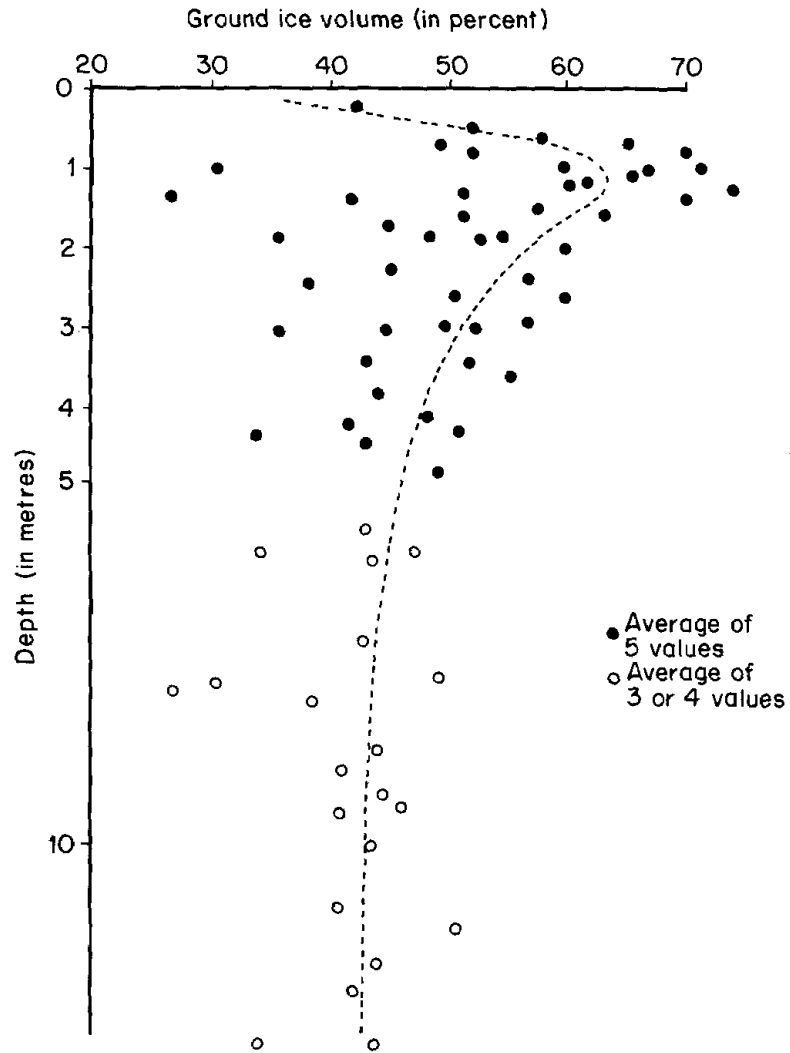
Ice

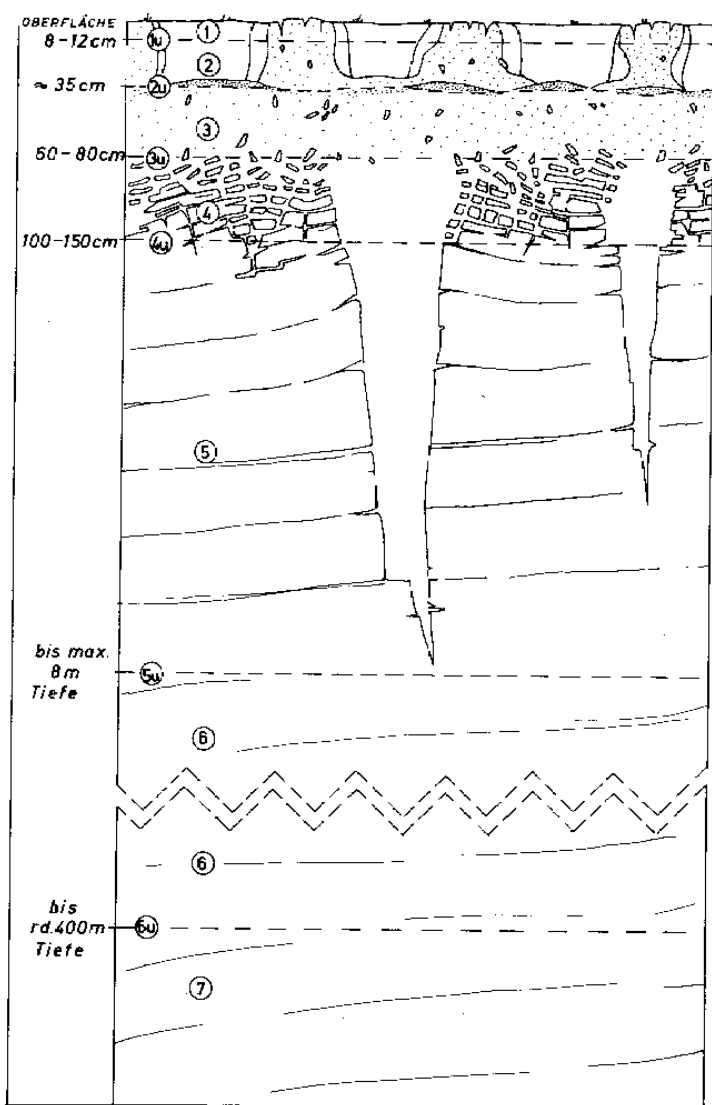


The **lattice structure of ice** also causes the about 9% volume expansion taking place when liquid water changes into solid ice.

Significance of permafrost

Significance of permafrost

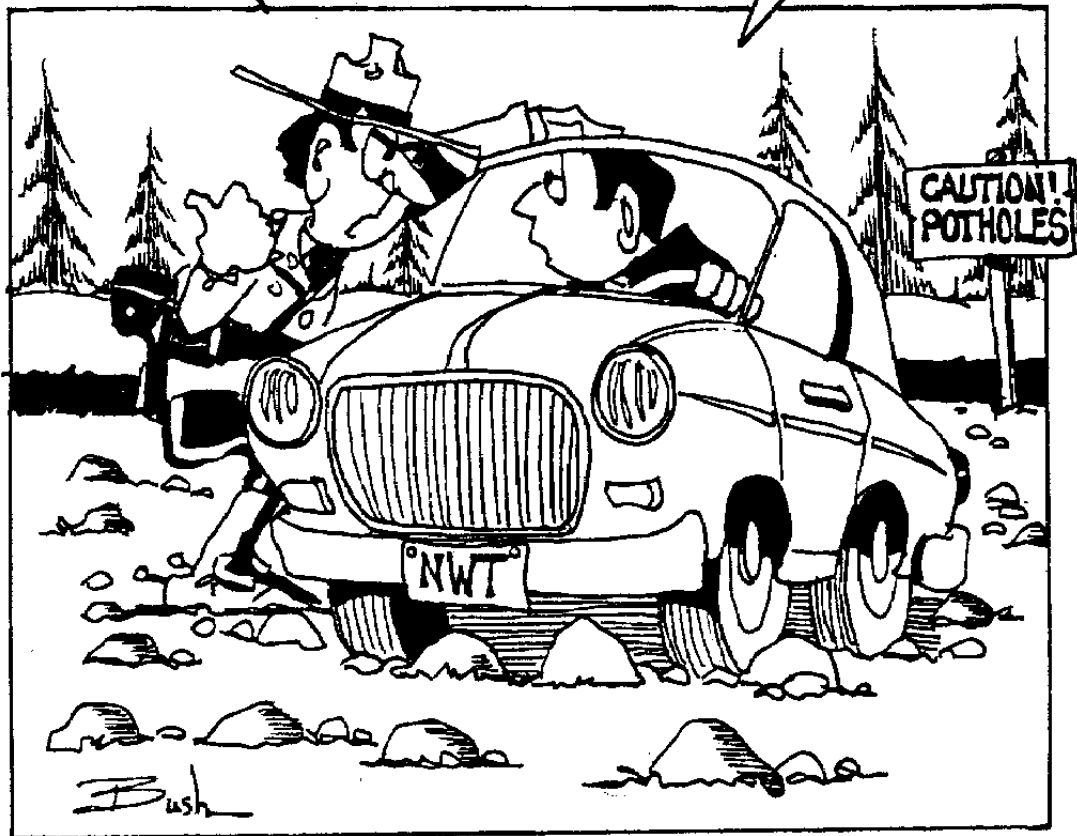






ANY PARTICULAR REASON
YOU'RE DRIVING IN THE DITCH
INSTEAD OF ON THE ROAD ?

FEWER BUMPS.



Landforms indicating permafrost

Large scale sorted phenomenon



Ice wedges



Large frost blisters



Pingos



Rock glaciers

